ON CERTAIN STUDIES WITH THE ERGOGRAPH.*

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The original idea which led to the investigation I wish to report was to study experimentally certain conditions of diminished mental and psychomotor activity. The conditions I had in mind were the depressed state of manic depressive insanity, the apathy of dementia præcox, certain states of general paralysis, also neurasthenia and the like. It is well known how much similarity such states may present when they are but slightly developed, and it was thought possible on the one hand to discover fundamental differences between these states, and on the other hand to obtain an insight into their nature.

Such studies are of course quite laborious, and in spite of the many experiments which were made I can present to you only an unfinished piece of work. Nevertheless, there are a number of important points which we can see even now, and the value of the method seems demonstrated. Moreover, in a field of work like ours where we have no cut and dried problems, but where much work is necessary for the formulation of such, the fact that this study yields certain definite problems seems to me also to justify its report.

In order to study these changes of activity it was necessary to investigate voluntary acts, and I chose the ergograph for the purpose. The model which I used in these experiments is in a general way the same as that described in an earlier paper[1] with the exception that certain modifications were introduced in order to insure more constant conditions from day to day, and that a ratchet arrangement was added to eliminate any considerable muscular work which might be expended in holding the weight back while it falls.

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[1] Hoch and Kraepelin. "Ueber die Wirkung der Theebestandtheile auf körperliche und geistige Arbeit." Psych. Arbeiten. I. Bd. p. 380.

It is of course not the mere strength of the individual which interests us and which, to a great extent, depends upon his muscular development. It was necessary to arrange the method so that features might be brought out in which the influence of the nervous system would be more evident and amenable to study.

The method employed was this: each person was made to write three successive curves with a rest interval of fifteen minutes between. In other words the person experimented upon had to rhythmically raise the weight to the utmost, until it could no longer be stirred (the rhythm being one second, indicated by a bell signal of the metronome); then fifteen minutes rest, etc. This was repeated either every day or every other day for a varied period of time.[2] By comparing the values of the three curves (expressed in mm.) with each other, and the values of the curves from day to day, we obtained relative figures, each individual setting as it were his own standard of strength. These relative figures of different persons could then be compared. The comparison was made not only between total amount of work done; but also between the pull-number of the curves and the average pull-height (*i.e.*, the total amount of work done in one curve, expressed in mm., divided by the pull-number).

The features we had to deal with were fatigue and recovery from fatigue, warming up and practice. The results of the six series of experiments were such that any marked deviation from the normal in fatigue or recovery from fatigue could be excluded. In regard to warming up, I may state that former experiments reported in the above quoted paper by Prof. Kraepelin and me had shown that frequently the second curve showed a striking increase over the first, an increase which owing to its more transient character was thought to be different from the influence of practice and which was regarded as due to "warming up." In a recent series of experiments with varying intervals made upon three normal individuals, the intervals being from five minutes to an hour in length, the second curve was higher in each case after an interval of fifteen minutes than after any other interval. It would seem that then fatigue had sufficiently passed away to allow the influence of warming up, still well-marked, to come most to the surface. This was the reason why in the experiments here reported fifteen minutes were chosen for the rest interval between two curves. In two normal cases the influence of warming up was well seen, while the pathological cases showed some deviations, some of which we shall take up in the course of our discussion. We may add here that the most probable interpretation of warming up seems to be that certain resistances have first to be overcome before the mechanism works at its best.

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[2] The number of experiments made on one individual varied from 30 to 80. To make more than 30 or 40 would have been unnecessary for the problem in hand, but was done owing to a study of periodicity which was carried along with this work, but which has no direct bearing upon the questions here discussed.

The influence of practice shows itself normally in a steady rise from work-day to work-day, and when we analyze this rise and study separately the pull number and the average pull-height of the first curve of each day we find that it is the pull-number which rises, while the average pull-height remains the same. Of course the absolute pull-height also rises, but it rises *pari passu* with the pull-number. This fact seems of interest and seems to show a remarkably constant relation between the activity of the central and that of the peripheral mechanism. For we have reason to think, as Kraepelin has shown, that if we stimulate the muscle alone to greater activity this increased activity shows itself (in voluntary muscular work of course) chiefly in the pull-height. The remarkably stable relation which we find here, through a long series of experiments, would seem therefore to give us some insight into the nature of practice in voluntary muscular work.

We will now pass from the normal to the abnormal cases and I will chiefly speak of one case of manic depressive depression in which the practice curve as well as the "warming up" shows very striking deviations from the normal.

In order to do this a few clinical remarks are necessary. Kraepelin has shown us that certain forms of "melancholia" and certain forms of "mania" belong together and constitute what he termed manic depressive insanity. It is a disease which, briefly, is characterized by two sets of symptoms, the most striking of which are psychomotor retardation, thinking disorder, and depression of feelings on the one hand; psychomotor excitability, flight of ideas and exhilaration on the other hand. These, if pure, constitute the depressed and manic forms respectively. Interesting combinations constitute the mixed forms. Now it was chiefly the mild phases of a depressive nature which interested me in this connection. It seemed possible with the ergograph to obtain a method by which psychomotor retardation might be demonstrated in cases in which it is clinically not appreciable. These mild phases are represented by cases which lead, as I have seen, to wrong diagnoses, when the element of marked emotional depression is absent. The cases are then called neurasthenia, hypochondriasis, etc. When the emotional depression is present they are simply called melancholia, and unless we have manic phases in the course of the disease their place is indeed difficult to determine. The most striking feature is a feeling of inadequacy. These patients claim that they cannot do things, cannot make up their mind to do them, and ordinary tasks assume great proportions. With this may or may not be associated a "melancholia," *i.e*, a marked emotional depression with self-accusation, etc. Sometimes only an irritated nervousness, or what may be called a chafing under the conditions which the nervous system imposes upon them characterizes these patients. This was the state of the patient we studied. He showed no appreciable psychomotor retardation. He has had a number of attacks all similar to his present one, and has not had any definite manic attack.

If we study now the results obtained in this patient, and regard in the chart[8] the lines representing the influence of practice and the lines representing the relation of the three curves to each other on individual days (averages of the first ten experiments are given) we find very striking differences from the normal cases. The rise in pull-number from work-day to work-day such as we have seen it in the two normal cases,[4] and such as we find it in the two cases of mild dementia præcox is here entirely absent; indeed, we even find a diminution in the pull-number. However, the average pull-height rises (and also the absolute pull-height), so that there is not an absence of a practice effect, simply an absence of one element, namely that of increasing pull-number. On the individual days we find again a striking difference from the normal, and again this is most marked in the pull-number. It consists in an unusual rise of pull-number from curve to curve. The combination of these two traits at once suggests that certain resistances exist which, as in the case of warming up, are overcome to some extent by the work. They differ from the resistances underlying the normal "warming up" by being much greater, by being still further overcome in the third curve, and by manifesting themselves preëminently in the pull-number. The further explanation would then be that though these resistances are temporarily overcome by the work, they are again encountered every morning so that any practice effect cannot show itself in the pull-number. The fact that practice in pull-number is absent, while practice in pull-height is present, might at first glance suggest that we have here an isolated practice of the muscle without a practice of the central mechanism; while we have suggested that practice of the normal individual shows itself in both mechanisms. As I have said, we have reason to think that in a general way the pull-height represents more the muscular, the pull-number more the central activity. I think such an interpretation would here be quite erroneous, as it seems unlikely that in voluntary muscular work an isolated muscle practice should occur. We have therefore still to look for a reason why these resistances show themselves preëminently in the pull-number. I think we can explain this by assuming that the resistances are chiefly encountered at the starting of the pulls, while the rest of the pull is easier. This would of course not affect the beginning (as it does not show itself in the extent of the effort) but the end of the curve, because with the increasing fatigue the resistances can no longer be overcome, and a number of pulls are cut off, as it were. The fact, however, that the pull-number rises from curve to curve shows that these resistances, offered to the starting of the pulls, are gradually overcome. How far they are overcome we do not know. We must therefore assume that each individual effort, or each pull, overcomes some resistance, so that at the end of the first curve something is gained in this respect; and, when the fatigue at the end of fifteen minutes has passed away to a great extent the curve has the benefit not only of the overcoming of resistances while it is in progress, but also the overcoming of resistances by the first curve. In the third curve we have a still further accumulation. The fact however that this alteration chiefly shows itself in the starting of the pull makes a sufficient effort nevertheless possible, so that practice is not absent but shows itself in an increasing pull-height. We shall see that in a case of dementia præcox, where we are probably dealing with a different kind of diminished ability to make an effort, there is a total absence of practice effect. We would therefore regard this practice in pull-height as central and peripheral just as in the normal; but associated with it we find the existence of certain resistances which are especially marked at the starting of each impulse. Probably the very fact that the work can overcome these resistances to some extent accounts for the fact that they show themselves preëminently in the begnning of each impulse. It may be that in cases in which the alteration is more marked we shall find a total absence of practice in pull-height as well as pull-number.

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[8] The charts were demonstrated when the paper was read.

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[4] Other normal cases have shown the same; they are not included here because the whole arrangement of the experiments was different.

It seems probable that this alteration is not one confined to psychomotor mechanism, but that we have here resistances which are offered to any effort: the thinking disorder which we find associated with the psychomotor disorder in these cases would point to this.

Further work will have to show whether this interpretation is correct. At any rate there exists a striking deviation from the normal. And we have found a method to demonstrate this alteration in cases where it is not recognizable by means of ordinary clinical observation.

If we imagine this difficulty to increase we should *a priori* expect that the initiation of voluntary motion or of any voluntary activity would become more and more difficult, until finally it almost wholly cease: and this is just what we find clinically in cases of almost complete akinesis and mental standstill which belong to this class.

We have further, if continued study proves the correctness of these observations, an evidence of the essential relation of these mild cases with the pronounced states of retardation; and, we need not assume the addition of new symptoms in the pronounced states, but simply an intensification of what we see here. These mild cases are troublesome because the characteristic retardation of the more pronounced cases seems absent. Here, it seems probable, we have demonstrated its presence, and there is hope that by further study and comparison we shall be able to recognize it more clearly even by superficial symptoms without tests. This is of course of the utmost clinical important, not only scientifically but practically so far as prognosis and treatment are concerned.

A word might be said about inhibition, a term which is often applied to psychomotor retardation. The fact that we find here resistances which are gradually overcome by the work itself, just as is the case in warming up, makes it seem more likely that the alteration is located in the mechanism concerned; rather than that it is the expression of the influence of one mechanism upon another, as would be implied by the conception of inhibition.

Finally, I may perhaps bring these findings into relation with a frequent observation in these mild cases, namely, that in the evening they feel better, and the still more striking fact that after a sleepless night they feel much better than after a good night. Perhaps this is due to the fact that resistances in both cases are overcome through the day and through the night.

Interesting is also the feeling of inadequacy of these patients which is perhaps accounted for by these resistances. This feeling of inadequacy seems in reality the more fundamental feature, which is always present in patients presenting no manic traits, while the intensity of the melancholy features are perhaps more dependent upon personal peculiarities.

You can see what an interesting set of phenomena this case presented, and how they seem to fit into the clinical picture.

On the other hand it furnishes certain problems. It will be necessary to study in the same way different degrees of this disorder. This is of course possible only to a certain rather small limit of intensity. It will be interesting to study mild manic forms, and above all those peculiar combinations constituting the mixed phases. It will be interesting to study cases of general paralysis which present similar superficial symptoms, also neurasthenia, traumatic neurosis and the like. The comparison with dementia præcox I had already undertaken, and am able to make some statements, but owing to the time which I have already taken shall limit myself to a few words.

First, I would call your attention to a mild case, the interpretation of which was somewhat difficult. It was at first thought that the diagnosis of manic depressive insanity could be made, but further study showed him clearly to belong in the class of dementia præcox. Now this case seemed on ordinary clinical observation to show a real psychomotor retardation, yet in him the practice curve was like that of the normal in many respects, while the warming up, though showing certain similarities, was different from that of the manic depressive. In some respects another mild case of dementia præcox resembled this, though I cannot go into that here. He also showed a normal practice curve. We see then that here, though there were superficial similarities, the experiment showed us results which were fundamentally different. Finally, in a very pronounced case we found absence of any practice and only very slight evidence of warming up. While we might expect that a pronounced case of manic depressive depression would show similar results, clinical reasons nevertheless decide us to regard this state as one of apathy. It is probable that the results here are due not to the existence of resistances, but to a different kind of diminished ability to make an effort.

It might be said that the one case of manic depressive insanity upon which I have laid most stress is not enough upon which to base conclusions. But it seems to me that the agreement of the findings with our clinical knowledge of the disease, and the fundamental differences which we found in other superficially similar cases, give weight to the results even in this one case, and show the value of the method.

I have had to limit myself in my discussion to the most important points, and reserve a more thorough presentation to an exhaustive paper on the subject, upon which further work is now in progress.

Various other questions which this study revealed I cannot touch upon, such as personal differences in the normal or the study of daily disposition in the normal. I have already taken enough of your time. At any rate, you can see that it is possible by means of the ergograph to study certain conditions in the insane and that these studies are promising.

DISCUSSION.

Dr. McBride asked Dr. Hoch whether in the case of the descending curve that expresses the results in a single case or a few cases or a law applied to a type. Also in regard to his remark in reference to the possible dissociation of muscular movement from central stimulation. Dr. McBride said it has been shown by physiology that after muscular movement the exhaustion is largely in the nerve centers.

Dr. Hoch replied that he had stated in his paper the study of manic depressive insanity represents thus far only one case as the other tracings which he had shown also represent one case each. In regard to the central fatigue which Dr. McBride seemed to regard as the only element which finally terminates the work, Dr. Hoch differed; both central and peripheral fatigue are probably to be considered.

Dr. McBride said he meant chiefly central fatigue and partial muscular fatigue.

Dr. Hoch remarked that the question was of course a difficult one and he could hardly go into its discussion here. It has been fully discussed in the paper which Kraepelin and he published some years ago "On the effect of the constituents of tea on mental and bodily work." He added that the alterations which he had demonstrated in his paper were of course unquestionably central in nature.